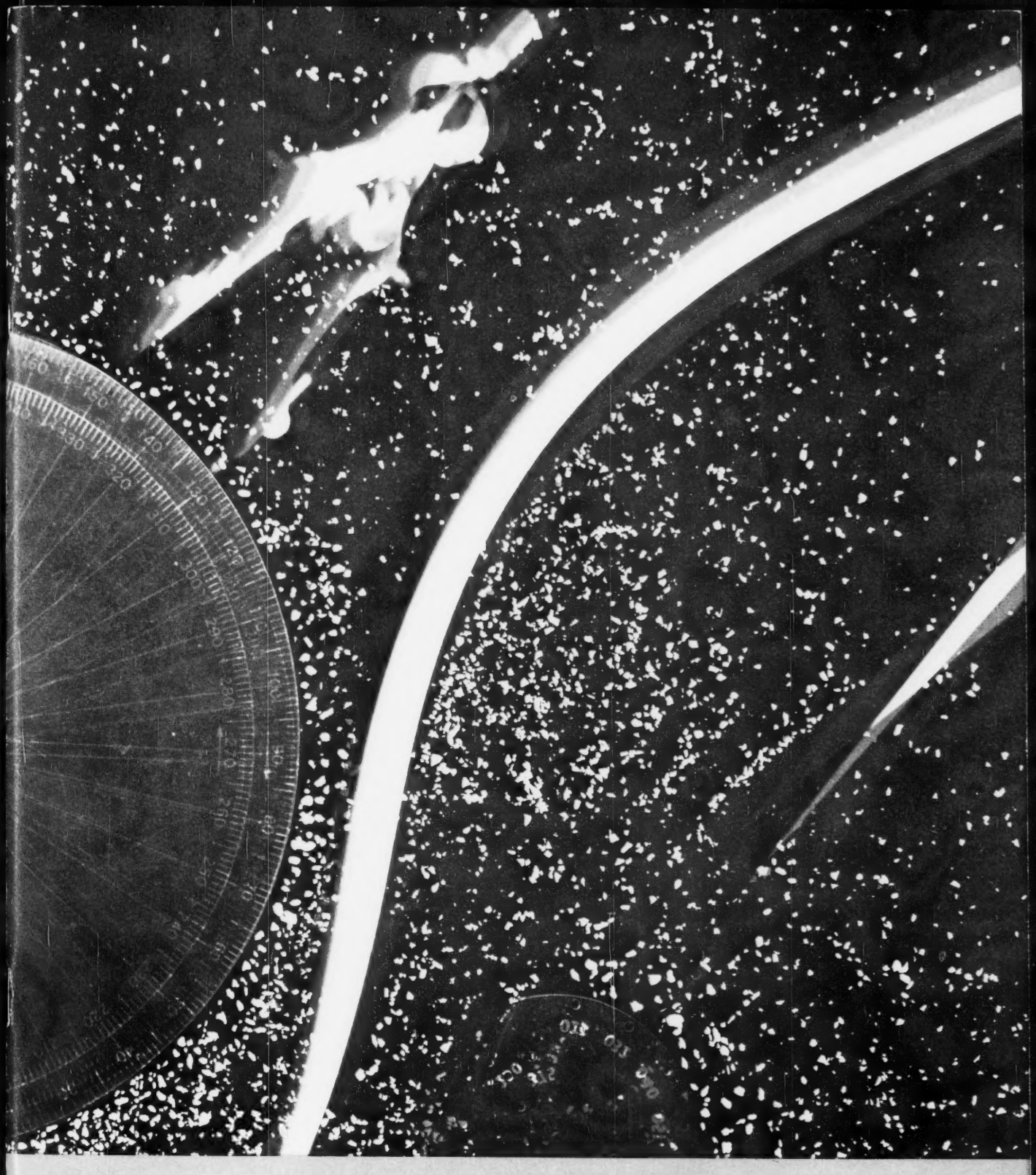
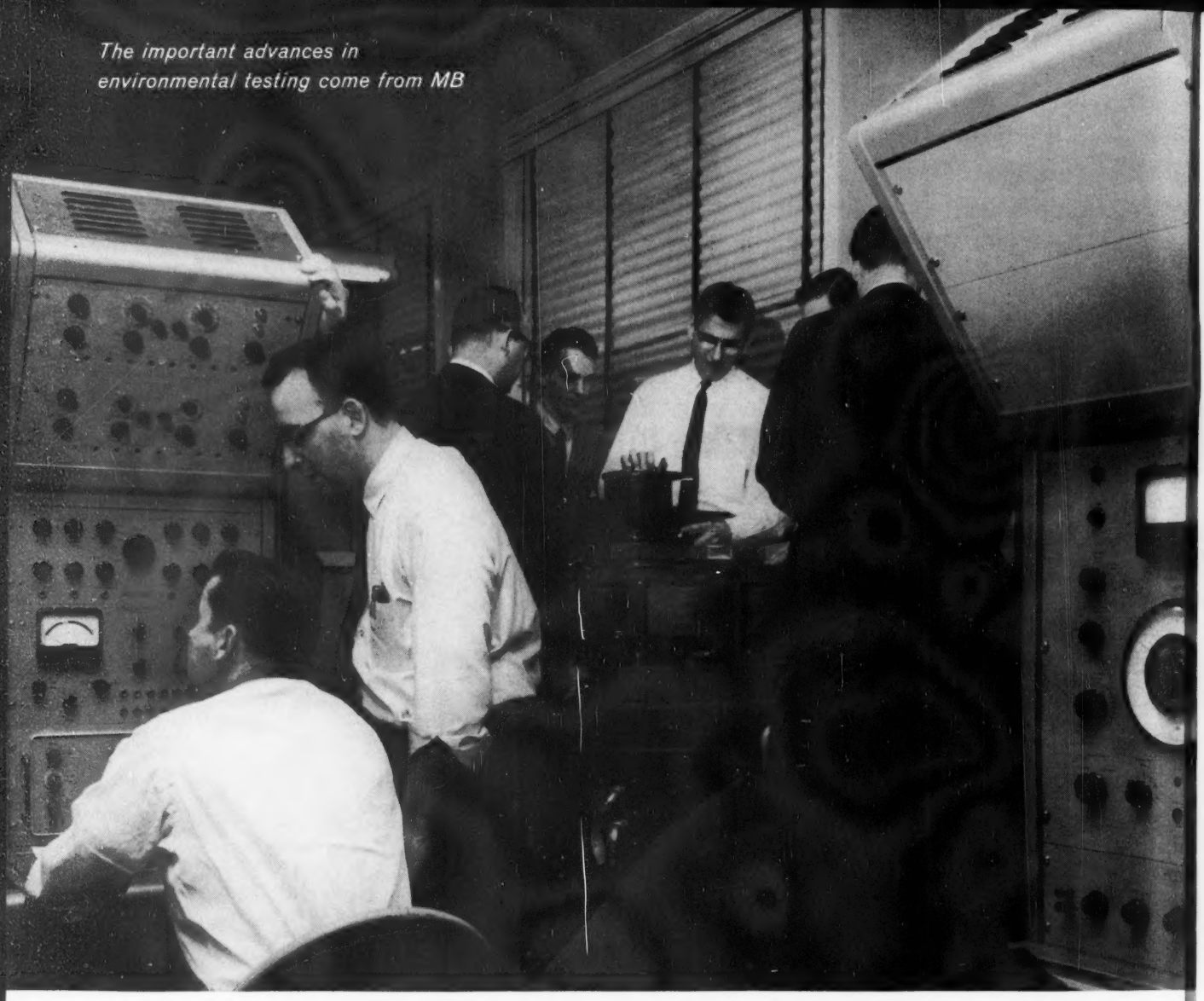


the JOURNAL of environmental sciences

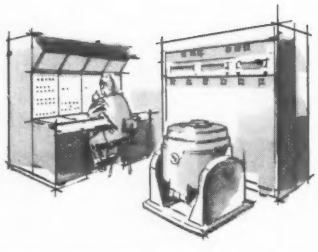
OFFICIAL PUBLICATION OF THE INSTITUTE OF ENVIRONMENTAL SCIENCES

APRIL 1960

The important advances in environmental testing come from MB



NEW seminar series in practical vibration testing starts April at MB



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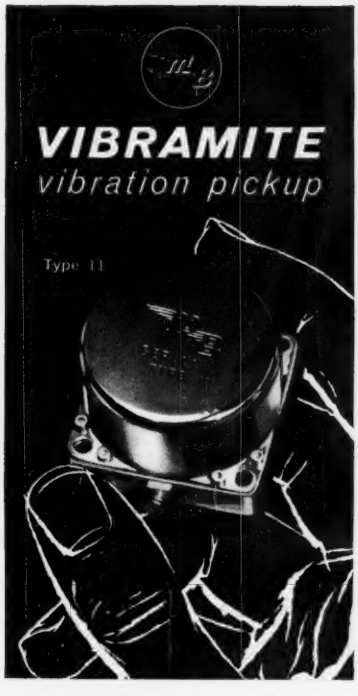

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the JOURNAL of environmental sciences

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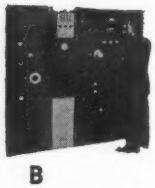

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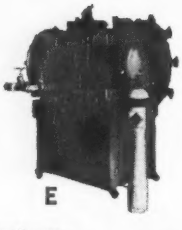

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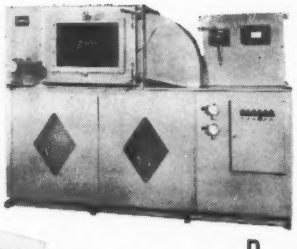

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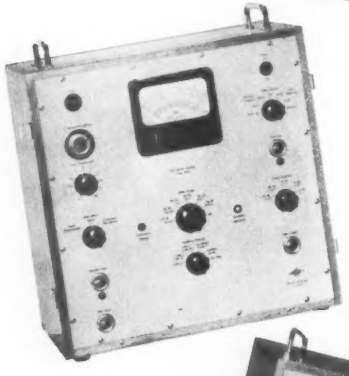

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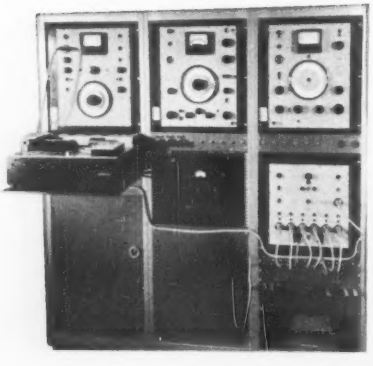

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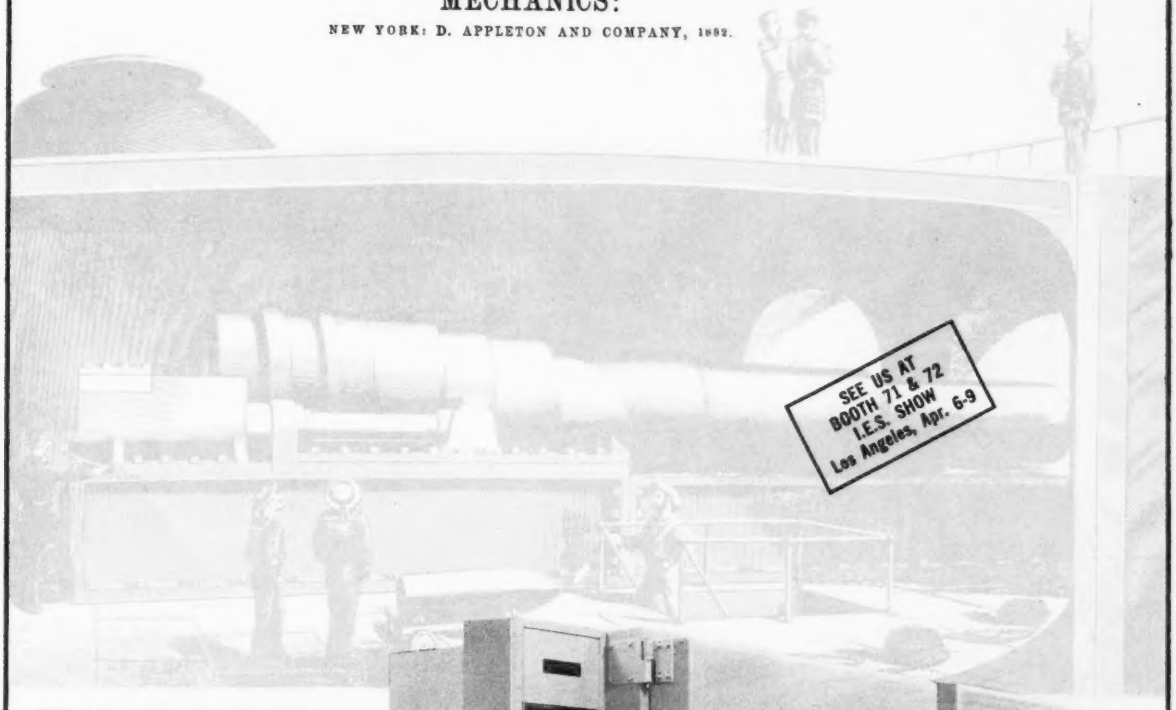

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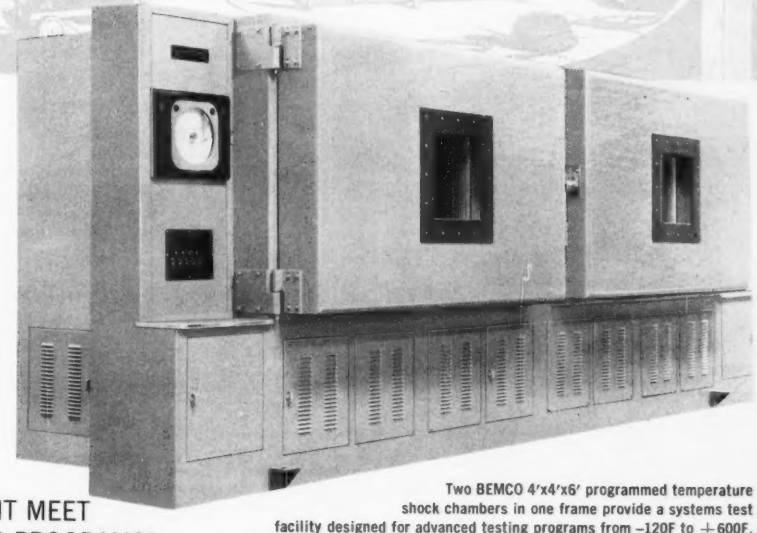

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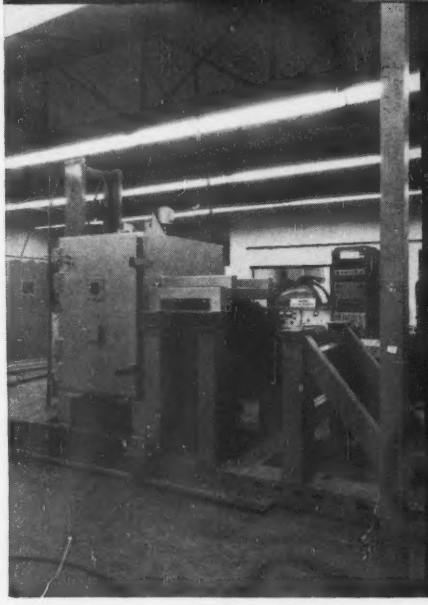

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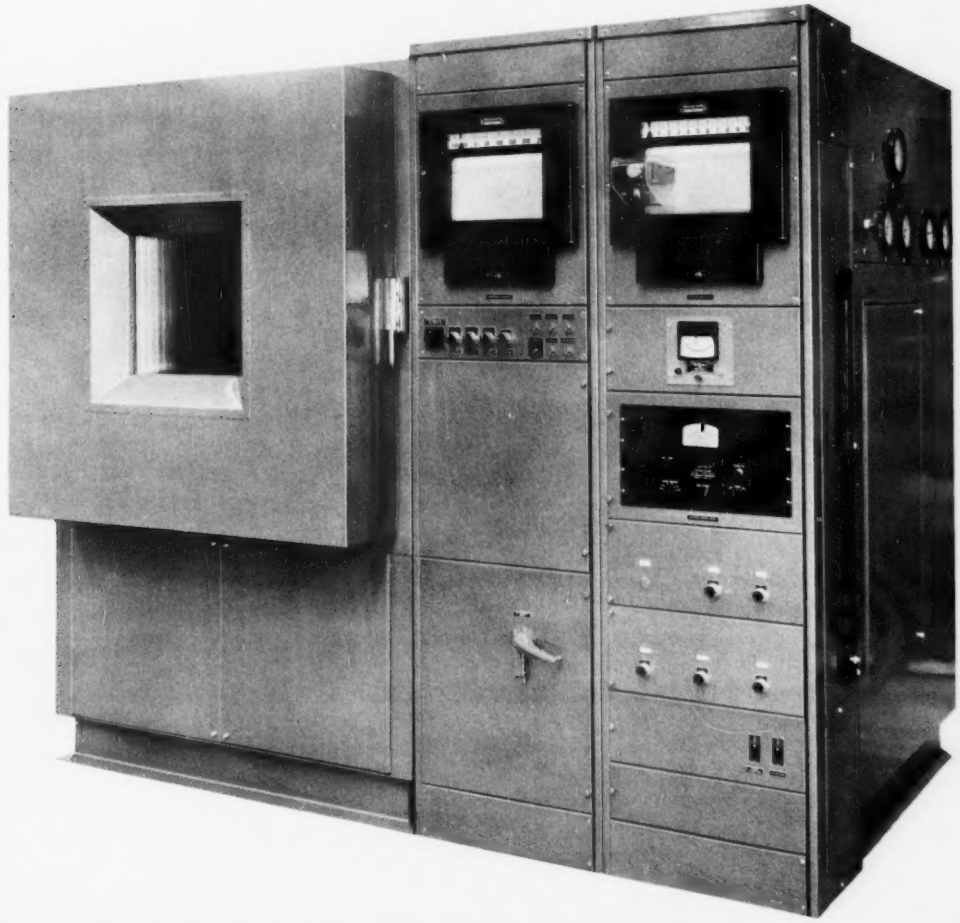

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William L. Vandal
Convention Chairman

1960 NATIONAL MEETING

National Meeting committee

The Los Angeles Chapter of the Institute of Environmental Sciences is the host for the 1960 National Meeting of the Institute of Environmental Sciences. The various activities and arrangements, capably handled by the chairmen from the Los Angeles Chapter, were guided by a desire to present to the attendees a technical program aimed at advancing the state of the art related to the hyper-environments.

William Vandal, National Committee Chairman in coordinating the activities of the chairmen, has endeavored to make this 1960 meeting a complete presentation of the latest advances in the field of Environmental Sciences. He has been assisted by **Neal Granick**, Program Chairman from the So. Ohio Chapter who has solicited persons prominent in the various phases of Environmental Sciences to present the latest developments in their work at the three day technical sessions.

Complementing the Technical sessions, exhibits, pertinent to the theme of the National Meeting, hyper-environments display equipment and services designed to aid the environmental scientist in his field of endeavor.

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Effects of Extreme Altitudes and the Need for Simulation by J. C. SIMONS, JR.

Acoustic Environment Present in Three Types of Small Missiles by J. B. OVERTON.

Analysis of Hyper-environments and Their Relation to Military Hardware in the Interior of a Space Vehicle by MAURICE H. SIMPSON.

Life Sciences and Hyper-Environments by A. M. MAYO.

Plant Growth in Outer Space by S. P. JOHNSON.

Confined Space Feeding by A. C. AVERY.

Fixture Resonance Effects on Shock Response by W. J. REICH.

Considerations of Vibration Environments in Space Flight Systems by GEORGE W. BROOKS & SHERMAN A CLEVENSON.

A Proposed Qualification Test Procedure for System Compatibility During Vibration by J. F. KELLEHER.

The Meteorite Environment by R. W. MUSTAIN.

A Summary of Direct Measurements of the Meteoric and Thermal Environments on Space Vehicles by W.MERLE ALEXANDER, H. E. LaGOW, O. E. BERG & L. SECRETAN.

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THE PRESIDENT'S CORNER

Fellow Members of the Institute of Environmental Sciences:

For this last report which I will make to you, I would like to give you the general view of the present status of your organization, and a progress report of the achievements of the 1959-60 officers. As I stated at the last annual meeting when I took office, it was our desire first, to put the organization on a firm financial basis, second to improve the communications between the officers of the organization and the members, and third, to raise the professional status of the Institute. The following are the accomplishments toward each of these goals.

First, financial standing. At the time of the merger of the Institute of Environmental Engineers and the Society of Environmental Engineers, the total treasury of the Institute of Environmental Engineers was $1,339.00. To this was added $500.00, from the Society of Environmental Engineers, as stated in the merger agreement. As of February 29, 1960 our bank balance was $14,300.00. It must be remembered, however, that this balance includes receipts for booth space and pre-registration for the forthcoming meeting, and against this, of course, there will be expenses. As a general picture, however, our net worth has increased due to the profit from the 1959 meeting and by virtue of the fact that we are now operating within income from our dues. A complete financial statement of the organization is prepared by a C.P.A. each April and is available for examination by any of the members of the Institute. I feel that I can say at this time that the Institute is on firm financial footing and further growth will provide us with financial means for accomplishing many worthy projects.

On the matter of communications, there has been improvement, but there is yet room for much more work in this area. We still hear from people who have sent in membership which seems to have gone astray. In one case this was traced to a breakdown at the local level; in other cases there have been mistakes or delays in the main office. In order to achieve our financial picture we have been working with a part time executive secretary, and I feel that Mr. Sander has done an excellent job in the time he has devoted to the task. It goes without saying that he is doing everything possible to improve the handling of membership and communications with members.

In the realm of technical recognition the Institute has fared well. We have reviewed one document on Standardization for the Department of Defense and submitted our comments to that department. We have reviewed a proposed standardization of Environmental terminology which was compiled by the Bureau of Weapons and have submitted our comments. We were also asked to obtain a complete review of the forthcoming Air Force Environmental handbook which is being compiled by McGraw Hill under contract to Wright Air Development Department. We have obtained competent reviewers for each section of the handbook and are submitting these reviews to W.A.D.D. In conjunction with this same project the Institute was requested to write the preface to the handbook, which we did. As those of you who have read past issues of the Journal know, the Institute is officially represented on the DODR&E AdHoc committee, which is preparing a Department of Defense Environmental Handbook. This is the effort which supplanted our own handbook effort, and to which

Continued on page 16

A SYSTEM FOR DIRECT READOUT OF VIBRATION TRANSMISSIBILITY

by F. A. KRAMER

ENVIRONMENTAL EVALUATION SECTION
SPACE TECHNOLOGY LABORATORIES, INC.

Introduction

The determination of vibration transmissibility factors is essential in the design of equipment expected to operate in a vibratory environment. Cognizance of transmissibility factors and their effects both from an amplification and attenuation standpoint is an invaluable tool in the design of vibration-testing equipment of predictable response and adequate control. It was in connection with a problem of the latter kind that the system described below was developed.

The Environmental Evaluation Section of Space Technology Laboratories, Inc., has developed a horizontal vibration facility of a new type, utilizing a plate supported by an oil bearing suspension and driven by an electromagnetic exciter*. To check the facility completely for dynamic properties the determination of transmissibility factors at thirty-three selected points, over a bandwidth of 30 to 2000 cps, was performed. Investigation of transmissibility factors in assemblies or packages to be vibration tested is of the greatest value in locating resonances which will amplify an applied excitation to the point of destroying parts or causing intermittent failures or malfunctions.

Klein, F.P., "A Final Report on a Horizontal Vibration Facility Using Electromagnetic Exciters," Journal of Environmental Engineering, April 1959.

Methods for Determination of Transmissibility

One of the possible methods for investigating transmissibility factors at many points in an assembly is the "quick-and-dirty" method of the hand probe. Such a method has a double drawback, being of dubious accuracy and at the same time limited in scope, since internal components and surfaces cannot be reached. Another possibility is the use of a stroboscope to determine resonances; this method suffers from the same limitation as the hand probe in that only those elements of a package which are visible can be tested. In addition, this method requires highly specialized equipment for any degree of accuracy and presents difficulties in observation of results at the higher frequencies where minute deflection can impart destructive accelerations.

A more generally applicable method of determining transmissibility factors, and one with an acceptable level of accuracy, uses a number of accelerometers mounted internally and externally at various points. These points are determined by the test engineer as being those most susceptible to resonance. The susceptibility of these points may result from structural design features made necessary by size or weight restrictions.

When the accelerometers have been mounted on the test package in those locations where resonance is expected, the package is vibrated and the output of the accelerometers is read on an appropriate indicator. From this information g levels and transmissibility factors can be computed. This procedure is both time consuming and tiresome, requiring laborious manual recording of the data from all major or suspected resonant points, location of their centers of frequency and bandwidths for "Q" values, and the difficult task of continuous reduction of the data to indicate the precise extent of the resonant condition.

In the case of the required checking of the horizontal vibration facility mentioned above, it was felt that an accurate and quick direct readout system would be necessary, since available time for checking the facility did not permit the testing and computation time required with the method just described. An accurate and thorough check of the perfor-

mance characteristics of the facility was indispensable, since a new design concept was used.

Direct Readout System

The system developed for direct readout of transmissibility factors makes use of a calibration system for the accelerometers, a g-follower device, and a direct-reading recorder, although any multichannel recorder may be used.

The calibration system is shown schematically in Figure 1. The accelerometers are mounted on the head of an auxiliary shaker together with a secondary standard (a vibration pickup) of high accuracy. The signal from the secondary standard is fed into a vibration meter. An excitation of 5-g rms, as determined by the standard and the vibration meter, is applied to the exciter. The output of each accelerometer is then fed into a g-follower device*. This g-follower (see Figure 2 and Figure 3) consists of a cathode follower, an amplifier, and a detector which accepts the a-c signal output of the accelerometer and converts this signal to a calibrated d-c level. Each accelerometer being calibrated has a separate g-follower, with a common power supply for all followers. A gain potentiometer included in each g-follower makes it possible to regulate the output so that all accelerometers have an equal signal strength, whatever their individual rated outputs may be.

The signals from the g-followers are fed directly into a 36-channel Minneapolis-Honeywell Heiland Visicorder. The recorder is calibrated in the following manner: The auxiliary shaker is turned off and the signal-energized recorder galvanometers set at appropriately located zero points along the recorder face. In the present instance these zero points were evenly spaced. The auxiliary shaker is then turned on, and the previously calibrated 5-g level introduced into the system. A convenient scale factor is selected, and the output of the accelerometers attenuated or amplified to coincide with it. In the case being described 1/10 in./g was used, making a 1/2-inch displacement for the 5-g level being used for calibration. Static (nonenergized) galvanometers were then focused at 1/2-inch intervals across the illuminated scale of the recorder, with one static galvanometer at the zero point and one at each 1/2-inch or 5-g interval up to a reading of 20 g's, coinciding with a 20-g input signal for system linearity. These static galvanometers provided steady traces at each 5-g increment, with a reference line at zero. The number of zero points, and hence of outputs being measured at one time, is limited only by the capacity of the recorder and the width of the paper. As noted above, the signal-energized galvanometer was set to read 5 g's with the calibrated 5-g input and, of course, zero with no signal. The displacement of the trace of this signal-energized galvanometer then indicates directly the g level of the accelerometer to which it is connected by reference to the steady traces made at 5-g intervals by the static galvanometers. Transmissibility factors are determined by simple observation of the number of these grid lines crossed by the trace of the moving galvanometer. No computations of any kind are necessary. If it is desired to cover greater ranges of transmissibility, the recorder calibration can be changed so that each grid line represents a multiple of the 5-g calibration level. During the check of the horizontal vibration facility, for example, the response at higher levels of excitation was measured with a 10-g calibration for each grid line.

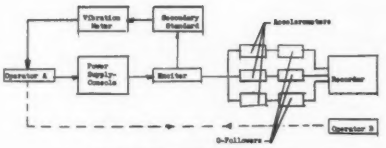


Figure 1. Calibration System for Accelerometers. (590)

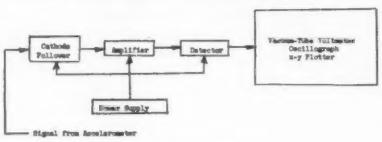
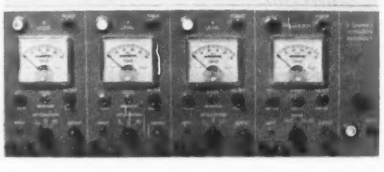


Figure 2. Diagram of G-Follower Circuit (590)

Figure 3. External Configuration of G-follower Device.



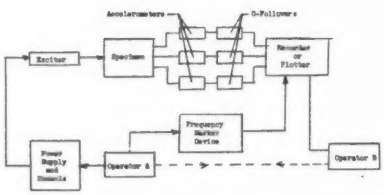


Figure 4. Transmissibility Readout System. (591)

In order to determine the bandwidths of the resonances found, it is necessary to have an indication of frequency recorded together with the g-level trace. For this purpose a marking device was installed, energizing one additional galvanometer at the edge of the paper by means of a pushbutton and a battery in parallel with a capacitor. This device was operated manually, but it was found that a high degree of accuracy could be attained by using a counter on the oscillator and a relatively slow sweep rate. Figure 4 shows the entire system.

Summary

Use of the above described method of direct readout of transmissibility factors eliminated many man-days of tedious computation in the checking out of the horizontal vibration facility for which it was developed. The results were obtained immediately

Continued on page 14

Designed and built by D. W. Hutchinson of the Environmental Evaluation Section, STL.

NOTES FROM THE EDITOR

CHARLES W. DANIELSON
TECHNICAL EDITOR

The 1960 meeting of the Institute of Environmental Sciences will soon be in progress during April 6 to 9. Papers being presented during the meeting cover many different areas related to environmental sciences. The authors of the papers have expended considerable effort in preparing and presenting the information during the three day technical session. The program committee has done an excellent job in arranging for the interesting three day technical series. The members of the Los Angeles chapter and committee chairmen have done equally well in providing facilities and arrangements as hosts for the national meeting.

An important feature of the meeting is that a complete set of the 1960 proceedings will be published and distributed to the members when they arrive. Thus attendees may select from the papers being presented and attend those in which they are particularly interested. However, although a large number of people will receive the complete 1960 proceedings with subsequent distribution of the information contained in the set of papers, the Institute provides another service in the distribution of information through articles published in the *Journal of Environmental Sciences*. Articles which are now submitted to the *Journal* for publication reach approximately 5,000 people directly concerned with environmental engineering throughout the entire year. Also, our subscriptions to foreign countries have been increasing significantly which essentially gives us world-wide distribution of the *Journal*. In addition to the yearly meeting, the *Journal* can publish and distribute throughout the world information concerning developments in the field of environmental testing during the entire year as these results are made known.

As mentioned in previous issues of the *Journal*, themes in our articles generally are in the following fields: All of the known environments, instrumentation associated with the environments, new techniques related to the environments, future environments and the fields of reliability and quality control.

I would like to discuss the previously mentioned categories and relate them to the National Meetings and the *Journal*.

1. The Known Environments

The majority of testing presently being conducted in the environmental laboratories consists of work limited to the known environments. Vibration, shock, altitude, temperature, humidity, salt spray to mention a few. Parameters in these environments have been well established by common practice and by military specifications. Many of the articles written and much of the equipment being built is related to the known environments.

2. Instrumentation for the Environments

Much of the instrumentation we use today was designed to accurately measure the parameters associated with today's environments, much of the equipment you will see at the meeting has been designed to do a better job and do it more accurately. Some of the articles or new products published in the *Journal* or presented at the meeting deal with new or advanced instrumentation.

3. New Techniques

As related to the environments and associated instrumentation, new techniques are constantly being developed. The national meeting and the

Continued on page 14

Continued from page 13

Journal provide an excellent means to distribute new information to all in the environmental field.

4. Future Environments

We are just encountering the requirements for the hyperenvironments. Zero gravity, radiation, complete vacuum, thermal gradients and combined environments will become increasingly important. Papers relating to these environments are being presented at the meeting and articles related to them will be published in the *Journal* as developments occur.

5. Reliability and Quality Control

Our President, *Harold Jones*, in a previous issue of the *Journal*, stressed the importance of reliability testing, with subsequent quality control, as important to the environmental engineer. Reliability testing and environmental testing are closely associated fields which can work to each others benefit. We hope that papers presented in future meetings and issues of the *Journal* will stress the importance of this relationship.

The purpose of the *Society* and the *Journal* is not only to extend the knowledge of the environments, but also to advance the latest techniques and methods of providing qualification of a company's product and insuring reliability of the product in the field.

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and with a high degree of accuracy, enabling the complete investigation of the vibration transmissibility of the new device within a few hours.

The method has been described here for the information of those concerned with obtaining a more complete knowledge of vibration transmissibility, whether in connection with component design or with vibration test equipment. It offers a rapid and accurate means of determining transmissibility factors at several points simultaneously without the necessity for time-consuming computations.

I. E. S. News Letter

At this time of the year, when we are looking forward to the National Meeting, many of the local chapters are electing new officers for the coming year. As the new slates of officers are known they will be published in the *Journal*. News of the various chapter's activities and results of the elections should be forwarded through the chapter secretary to the Vice President of local chapters with duplicates to the address of the *Journal*. In this issue of the *Journal* we wish to give recognition to those people that served during the past year as Presidents and National Directors of the various local chapters.

Mid-Atlantic Chapter
Martin Schletter - President
Dave Askin - National Director

Boston Chapter
Robert J. Graeff - President
M. L. Talf - National Director

Northern California Chapter
Robert C. Geiger - President
C. M. McCarty - National Director

Chicago Chapter
Robert Jacobson - President
Ed Fieldmann - National Director

Detroit Chapter
Arthur B. Billet - President
R. G. Yaeger - National Director

Los Angeles Chapter
Jerome Bakalish - President
Mark Christensen - National Director
Allen Marshall - National Director

New York Metropolitan Chapter
Socrates N. Vanoudis - President
Norman Ponge - National Director
John Regazzi - National Director

Southern Ohio Chapter
Donald J. Fox - President
Bob Boggild - National Director

Southern Tier Chapter (So. New York)
W. G. Murray - President
K. Koon - National Director

San Diego
Robert Inabinette - President

Chairman – Standards Committee
A. E. Surasky

Appreciation is expressed to the other officers in each of the local chapters for their work during the past year. The progress and accomplishments of the local chapters is extremely important to the National Organization. Increase in chapter membership and forming of new chapters should be encouraged wherever possible.

Leon Carver
Vice President, Local Chapters

OPERATION of VACUUM EQUIPMENT in CONNECTION with ALTITUDE TEST CHAMBERS

by PAUL H. BRANDT, MGR.

ENVIRONMENTAL PRODUCTS DIVISION
MURPHY & MILLER, INC.

Out-gassing and evaporating of moisture in altitude chambers, are many times mistaken for leaks in the shell of the chamber. If these two troublesome factors are thoroughly understood, many man-hours of fruitless leak testing and checking can be saved while operating altitude test chambers. Because of this out-gassing and evaporating condition, certain limitations should be placed on specifying and designing altitude test chambers.

The addition of a humidity cycle in an altitude chamber, may, on the surface appear to be the logical approach to economizing on test equipment. However, if all of the facts are taken into consideration, the addition of humidity in an altitude chamber can become a very costly accessory.

An altitude chamber, as everyone is aware, is not a cheap test facility, whereas a humidity test chamber designed for a temperature range of +35°F. to +200°F. and available with a 0°F. cycle, can be purchased for a fraction of the cost of the simplest form of altitude temperature chamber.

Humidity tests usually require long periods of time, and if the altitude chamber is used for these humidity tests, we are restricting a very expensive piece of equipment for the humidity test, which could be accomplished in a separate, comparatively inexpensive test chamber. By proper planning of the future testing programs required, the initial cost of a separate humidity and altitude test chamber can be easily justified, economically over the purchase of one combined chamber. The argument against two chambers is the required floor space in the testing laboratory; therefore, any future planning of test facilities should include adequate floor areas.

In analyzing the problems of operating an altitude chamber which is equipped with a humidity cycle, one merely needs to consult a standard steamtable, where we discover that the evaporation of water and water vapor as the pressure within the chamber is reduced, constitutes an astronomical volume to be evacuated before high altitude conditions can be reached.

Water at sea level pressure boils at +212°F. As the pressure on any water or water vapors left in a chamber is reduced, the boiling or evaporating temperature of the water is reduced until at 8 MM.HG. (100,000 feet altitude) water is evaporating at 47°F. In other words, if the temperature in the chamber is above 47°F. this heat in the chamber will cause the water to boil or evaporate.

At sea level pressure and at +212°F., water expands approximately 1600 times its volume in changing from a liquid to a vapor or steam. At 8 MM.HG. (100,000 feet altitude), water evaporating expands approximately 122,500 times its volume in liquid form. This phenomenon is very advantageous when used in connection with the design of a steam engine, but presents a mammoth pumping problem in an altitude chamber. As the pressure in the chamber is reduced to 4.5 MM.HG., the boiling or evaporating temperature of water is reduced to +32°F., which is the freezing point of water.

As the pressure in the chamber is further reduced, any water left in the

chamber turns to ice. If the surrounding temperature in the chamber is above the melting point, this ice evaporates and continues to expand, and must be removed by the evacuating system of the chamber.

This evaporation of ice to a vapor without first changing to a liquid, is known as "sublimation". The evaporating or sublimation temperature of any ice left in a chamber is reduced as the pressure is reduced. At 250,000 feet altitude (17 microns) sublimation occurs at approximately -70°F.

One pound of water occupies .016022 cubic feet of space. However, in evaporating at 4.5 MM.HG. this expands to 3304.5 cubic feet of vapor. This vapor must be removed from the chamber before satisfactory altitude performance can be obtained. If this was the only problem, we still would not have too much trouble in obtaining a high vacuum, providing we had sufficient time for evacuation or by increasing the capacity of the vacuum pumping system. However, moisture will condense in the oil of the vacuum pump, causing further difficulty. The addition of a gas ballast on the vacuum pump will help reduce moisture in the pump, but will also decrease the pumping efficiency and lengthen the evacuating time.

The test engineer or operator of an altitude chamber equipped with a cascade refrigeration system, has available to him a built-in refrigerated trap. This trap can act as a vacuum pump in freezing out any condensable gases before entering the pumping system, and holding them in the form of ice below their sublimating temperature.

When operating an altitude chamber in the higher altitude ranges (above 90,000 feet), whether equipped with humidity or not, the refrigeration system should be used to freeze out the moisture which may be left in the chamber and keep it out of the pumping system.

By intelligent use of the refrigeration system on an altitude chamber, large volumes of condensable gases can be handled without appreciably affecting the pumping speed of the vacuum pump. To hold any ice formation and keep it from sublimating or evaporating, the temperature of the ice must be kept well below its sublimation or evaporating temperature. However, we have found that usually because of insufficient knowledge of the operator, untold difficulties have been experienced in obtaining high vacuum conditions, especially when a humidity cycle is included in an altitude test chamber.

Because of the difficulties which can be experienced when humidity is included in an altitude chamber (especially for operation above 8 MM.HG.) it is highly recommended that a separate chamber be used for humidity testing. This is a MUST in chambers designed for altitude ranges in the 200,000 to 350,000 feet altitude class.

If a humidity cycle is included in a chamber designed to simulate these altitude conditions, the chamber must be equipped with a separate freeze out system to remove all traces of moisture before entering the pumping system. Because of the complexity of an automatic freeze-out system and/or operator failure to follow instructions, a system of this type is not recommended unless the outgassing and moisture problem is thoroughly understood by the operator of the chamber.

The following pressure-temperature relationships should be used as a guide to determine the required coil temperature to keep moisture from entering the pumping system:

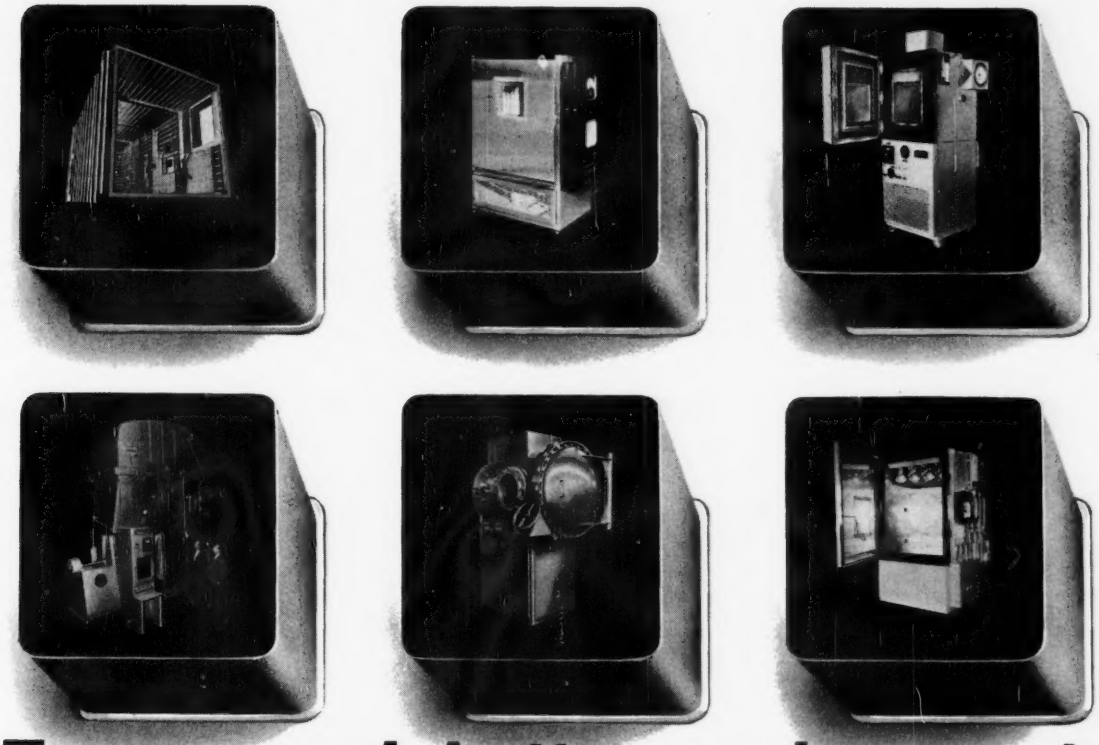
8 MM.HG.	approx. 100,000 ft. altitude	47°F.	evaporating temp.
4.4 MM.HG.	approx. 115,000 ft. altitude	32°F.	evaporating temp.
1 MM.HG.	approx. 150,000 ft. altitude	0°F.	evaporating temp.
530 microns HG.	approx. 170,000 ft. altitude	-10°F.	evaporating temp.
17 microns HG.	approx. 250,000 ft. altitude	-70°F.	evaporating temp.
0.5 microns HG.	approx. 315,000 ft. altitude	-110°F.	evaporating temp.
0.137 microns HG.	approx. 350,000 ft. altitude	-130°F.	evaporating temp.

Continued from page 10

you will be asked to lend your time and talents. The general outline has been completed and the detailed outlines are due for completion in the near future. At this time the writing chore begins and much help will be needed.

The Institute has also requested the American Standards Association to undertake a project on standardization of Environmental terminology. The A.S.A. called a meeting this February at which approximately 45 representatives were present and presented the proposal for consideration. It was accepted and the Institute of Environmental Sciences holds the secretariet for the project.

In conclusion I should like to publicly compliment the officers and other members of the Executive Committee for their excellent work. This has been a year in which the officers of this organization have carried a load which in most technical organizations is handled by the main office, but that they have done so with dispatch and ability is to their credit. It is my sincere hope that the incoming officers will be able to succeed where we have not, and to improve on our accomplishments where we have succeeded. It has been a pleasure serving you.



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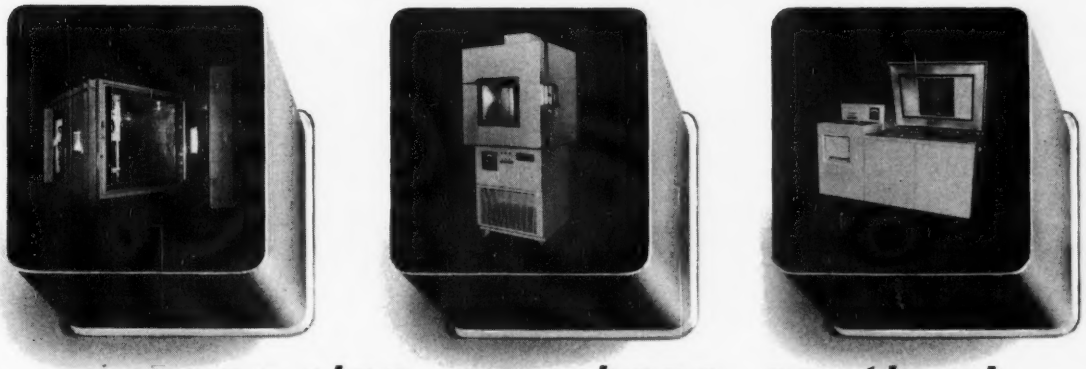

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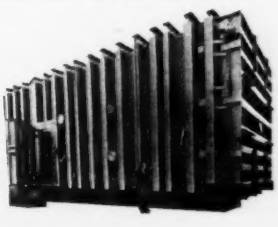

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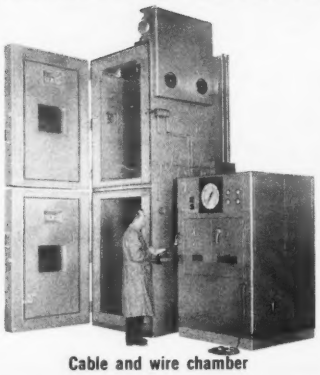
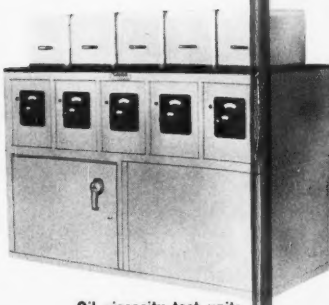
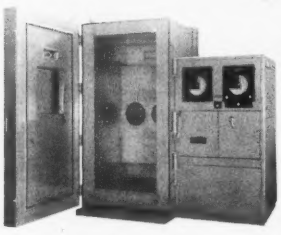


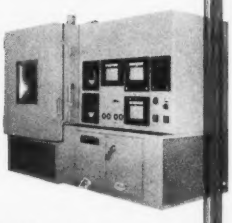
Cable and wire chamber



Oil viscosity test units

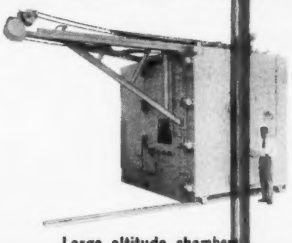


Relay rack test unit

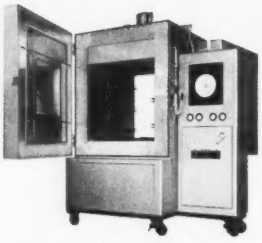


400,000 ft. altitude test chamb

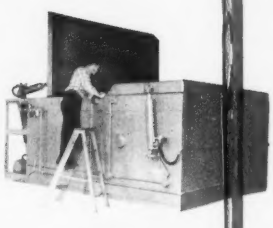
Explosion test chamber



Large altitude chambers



"Pass through" double duty units



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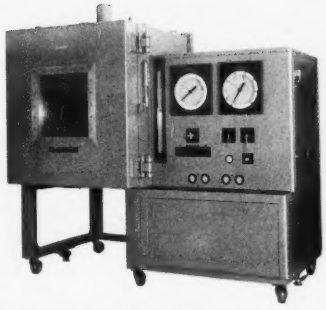
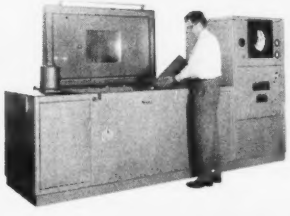
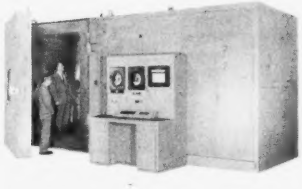


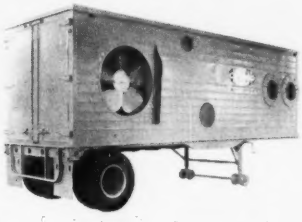
Altitude chamber with external shaker



Concrete test chamber

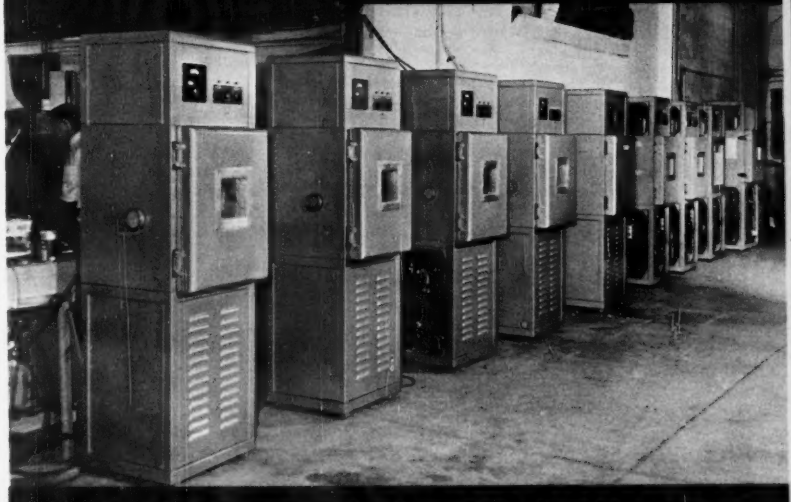


Packaged "walk-in" altitude test chambers



Mobile test chambers

5,000 cu. ft. Conrad chamber recently shipped to missile center. Five railroad cars were required.



2 cu. ft. "Temp Rac" chambers. Conrad combines precision engineering and production techniques to meet demand for various stock model chambers.

CHICAGO
William Nostrand
5111 W. Diversey St.
MErrimac 7-3303

TOLEDO
M. Denver Armstrong
Home Office
EX 2-3161

ST. LOUIS, MO.
Warren Hull
828 Thornberry
TAylor 2-2241

ROCKY MOUNTAIN STATES
Parrish Electronics
1804 S. St. Paul
Denver 10, Colorado
SKyline 6-9455

CLEARWATER, FLA.
W. Ben Wimberly
Robert F. Pond
532 S. Fort Harrison Ave.
3-7072

WASHINGTON, D. C.
District 7-2696

ORLANDO, FLA.
GArden 5-3083

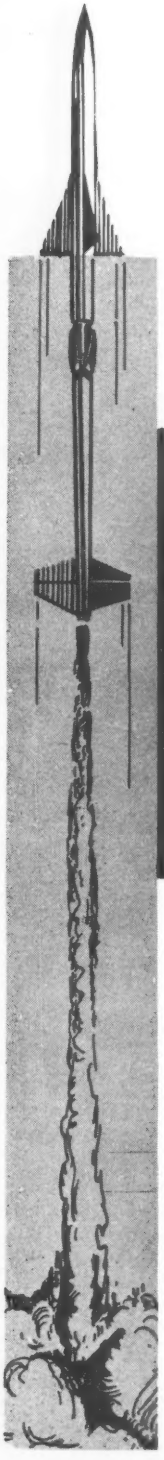
SEATTLE
Refrigeration Engineering
1718 Broadway
Seattle 22, Washington
A. H. Frost
EA 3-8940

CONRAD Inc.

HOLLAND, MICHIGAN

flight testing on the ground

Environmental and Performance Testing for Quality Control, Reliability, and Qualification of Electrical, Electronic and Electro-Mechanical Components, Sub-Assemblies and Assemblies



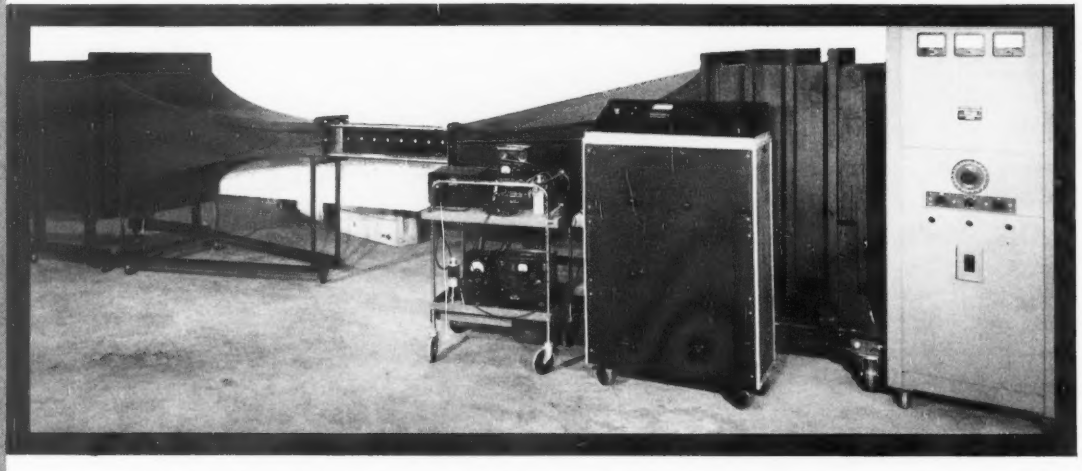
RANDOM NOISE ACOUSTICAL TESTING

Frequency spectrum: 75 cps to 10 K cps

Sound pressure level:

153 db (re: .0002 dynes/cm^2) in test chamber 5" x 5" x 16"
150 db in test chamber 8" x 8" x 40"
135 db in test chamber 40" x 40" x 40"

INTERMEDIATE SOUND PRESSURE LEVELS AND CHAMBER SIZES ALSO AVAILABLE



Acoustical vibration has recently been found--by the major airframe and missile manufacturers--to be an environment of prime importance in structures and electronic gear associated with jet and rocket engines. Rototest has developed and has operational a complete facility for testing components in high intensity sound vibration; much exceptional behavior has already been found in parts subjected to this environment.

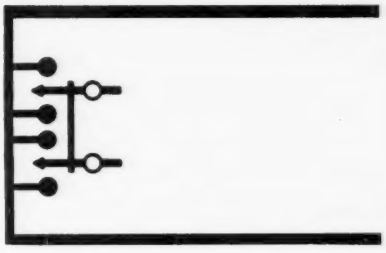
Rototest is accepting requests for proposals to supply complete Acoustic Vibration test facilities.

ANOTHER ROTOTEST FIRST

CINE-RADIOGRAPHY: *Dynamic application of X-ray motion pictures to the study of behavior of electrical, electronic, electro-mechanical, hydraulic components, assemblies and sub-assemblies while under such environmental stresses as vibration and shock.*

rototest laboratories, inc. *2803 Los Flores Blvd., Lynwood, California*

TECHNICAL INFORMATION



THE JOURNAL OF TEFLON

A new publication of interest to design engineers, presenting the latest and most important information on *"Teflon"* fluorocarbon resins has been announced by the E.I. du Pont de Nemours & Co. This new publication will be published monthly and will contain business news about the *"Teflon"* resins, comments and questions from readers, and an occasional editorial note.

For your copy of the January 1960 issue write to:

Polychemicals Department
E.I. du Pont de Nemours & Co., Inc.
Wilmington 98, Delaware

DESIGN IDEAS

Another first issue is now available in the "Design Ideas" published by Electro Scientific Industries. This first issue is devoted to voltage divider accuracy and calibration. Future issues will discuss new instruments and other techniques in detail.

The January 1960 issue may be obtained by writing to:

Electro Scientific Industries
7524 S.W. Macadam
Portland 19, Oregon

STOPWATCH BUYER'S GUIDE OFFERED BY HEUER

In a new 16-page catalog of 66 improved stopwatch styles (with accessories) Heuer Timer Corporation, New York City, offers the most complete guide to the proper selection of manual timing devices and chronographs it has ever made available to industry.

The literature describes several methods of operation, through different combinations of slide, side-button and crown actuation. Some of the stopwatches start, stop and continue; some start, stop and fly back; some offer both methods of usage. Split-action timers with two overlapping sweep hands (so that one can be stopped while the other goes on) are shown. Accessories include: sequencing boards for time-study, protective cases for certified chronographs, and bench stands which permit watch operation by finger tip or foot tread. Panel and dashboard models are new additions.

Gaston G. Wiley, Mgr.
Heuer Timer Corporation
441 Lexington Avenue
New York 17, N.Y.
OXford 7-2150

CONTRACT INSTRUMENTATION AND EQUIPMENT RENTAL

A new 14 page brochure describes oscillographs, transducers and accessory equipment which are available on a rental basis. Three pages of the brochure describe the measurement service available for flight, mobile and field test programs. Pictures of the most popular recorders are included. Transducers for measurement of force, pressure, displacement, flow, acceleration and strain are listed by range. Brief descriptions of recording equipment includes paper speeds, number of channels, and response.

For your copy write to:

Datacraft Instruments Co.
9210 S. Vermont Ave.
Los Angeles 44, Calif.

STATHAM INSTRUMENT NOTES

This issue provides schematics for single shunt calibration of zero line resistance, four wire, five wire and six wire systems. It also discusses the effect of transmission line resistance in the shunt calibration of bridge transducers.

Copies may be obtained by writing:

Statham Instruments, Inc.
12401 West Olympic Blvd.
Los Angeles 64, Calif.

LEAK DETECTOR BROCHURE

A four-page brochure containing tables of conversion factors, formular, performance charts, hints and other useful information for users of mass spectrometer-type leak detectors is offered by the Analytical and Control Division of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co.

Copies of bulletin 1857 are available from:

CEC
360 Sierra Madre Villa
Pasadena, California

CARBON DIOXIDE BROCHURE

Profusely illustrated brochure on the properties and uses of CO_2. Physical and chemical properties of the gas, liquid and solid are discussed. Several types of storage systems with associated controls are pictured.

For your copy contact:

Any Pureco Regional office or,
Pure Carbonic Co.
150 East 42nd St.
New York 17, N.Y.

BACK-TO-BACK CALIBRATION OF ACCELEROMETERS

by
WILLIAM F. COX

CHADWICK-HELMUTH COMPANY

Many methods exist and have been proposed for the dynamic calibration of accelerometers over the 5 to 2000 cps range covered by present specifications. An excellent discussion of many of these methods appeared in the June 1959 issue of the *Journal*, authored by Alvin Kaufman.

The precise and direct calibration by interferometry or reciprocity are complex, tedious, somewhat critical in method, and expensive. In short, they are beyond the reach of most vibration laboratories. The precise and direct calibration by the "streak" method, using a microscope to measure displacement, is simple and inexpensive, but is limited to displacements of say .050, and to frequencies usually below 100 cps. An expedient well within the reach of most labs, then, is to select a "standard" accelerometer, protect it from the hazards of temperature extremes, shock, and rough handling, and "calibrate" the working accelerometers by comparing their outputs when they are vibrated back-to-back with the "standard". Some measure of true calibration can be added to this method if direct calibration by the "streak" method is also used on either the working accelerometer or the "standard", so that the low frequency end of the dynamic range is calibrated. An additional measure of true calibration can be added to the method if the "standard" accelerometer is periodically calibrated by the interferometer or reciprocity methods by a qualified lab, as NBS or one of the accelerometer manufacturers.

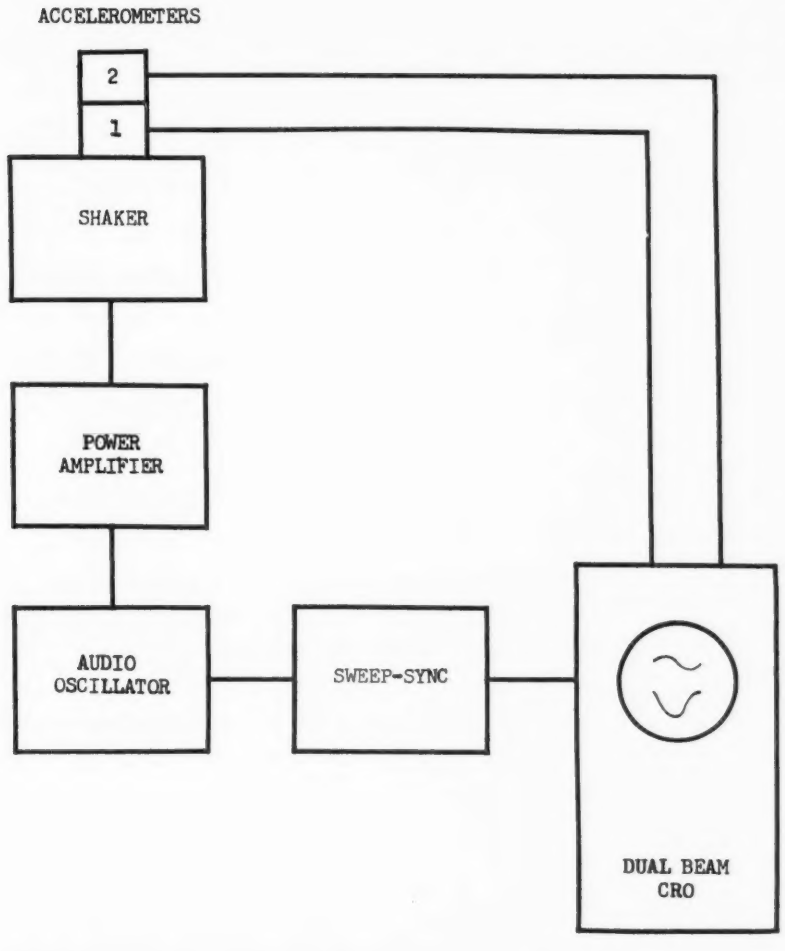
It is the purpose of this article to describe simple instrumentation that is needed in the back-to-back method, with several novel features. The principal requisites for the accelerometer chosen as the "standard" are time, temperature, and shock stability, and a high natural frequency. Manufacturer's recommendations will be helpful, and there are several crystal accelerometers on the market with natural frequencies over 35 kc, which, assuming .1 damping factor, will be within ½% of very low frequency output at 2 kc, theoretically.

As indicated by Alvin Kaufman, definition of the output of the working accelerometer requires:

1) pure sinusoidal motion
2) motion in accelerometer's sensitive axis only
3) monitoring of peak or rms amplitude
4) monitoring of phase shift with respect to the "standard"

A convenient and unique CRO display that gives this information can be had from a system composed of these elements:

1. "Standard" accelerometer, oriented sensitive to Z axis, [1] and amplifier
2. Working accelerometer, back-to-back with the "Standard", [2] and amplifier
3. Dual Beam CRO (or a single beam with electronic switch)
4. Sweep-Sync, a tracking sweep control for the CRO
5. VTVM
6. Fixture
7. Shaker system



8. Additional monitoring of the table motion for possible crosstalk in the X or Y axes can be done by the following additional equipment.

X_1 accelerometer and amplifier

X_2 accelerometer, or counter weight to keep the moving mass symmetrical

Y_1 accelerometer and amplifier

Y_2 accelerometer, or counter weight to keep the moving mass symmetrical

X_1 and Y_1 accelerometers need not be standards, but should be units selected for low crosstalk sensitivity. Their sensing axes should be 90° to the Z axis and each other.

The dual beam CRO permits close comparison at all frequencies of the waveshape and phase of the working accelerometer versus the "standard". Neither meter nor CRO amplitude readings should be plotted unless the trace for the "standard" accelerometer is a good sine wave, and some frequencies may have to be avoided where shaker system or fixture resonances prohibit sinusoidal excitation. Should the excitation be sinusoidal, as shown by the response of the "standard", with harmonics present in the output of the working accelerometer, this should go in the calibration record as an important limitation on the working accelerometer.

The Sweep-Sync automatically sweeps the CRO to display exactly one cycle for any frequency from 5 cps to 100 kc. It saves a great deal of time by eliminating repetitive manual adjustment of the CRO sweep, and also makes these important contributions to the measurements:

1) The resolution of the CRO for harmonic distortion is enhanced, since the X axis is always expanded and frozen even though frequency is changing. This also makes it convenient and easy to define frequency bands where the system is definitely sinusoidal or definitely distorted.

2) Where one cycle has been chosen for display, the full width CRO sweep becomes 360°, and the phase relation between the "standard" and working accelerometer can be directly scaled in degrees.

In operation the frequency range desired for calibration would be slowly swept to get a "quick look" at resonances, phase shifts, and harmonic distortions present in accelerometers and system. Data would then be taken at desired frequency points as follows:

1) Be sure output of "standard" accelerometer is a sinusoid.

2) Meter output of X_1 and Y_1 accelerometers to be sure that negligible components of table motion exist in the X and Y axes.

3) Switch CRO display to "standard" and working accelerometers, and set desired "g" level of the system using previous calibration of the standard.

4) Read voltage output of working accelerometer.

5) Scale phase relation of working accelerometer.

6) Note waveshape of working accelerometer.

NEW PRODUCTS

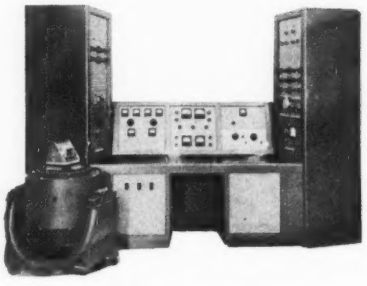
LING ANNOUNCES NEW "RANDOMATIC" SYSTEM

A new compact random wave vibration testing system for automatic programming – the Randomatic – is being featured by Ling-Altec Electronics, Inc.

The Ling Randomatic is a completely packaged random noise and sine wave vibration testing system designed for standardized repetitive testing and push-button operation over an extended frequency range of 5 up to 10,000 cps. No impedance changing or manual power factor correction is required over this entire range.

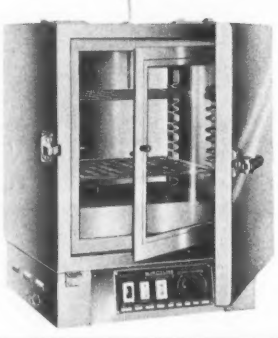
All Randomatic components including power generator, field and degaussing supply, cycling oscillator, servo system and stop-start controls, are housed in a single compact metal console measuring approximately 4 feet by 10 feet. Only the Ling Electro-dynamic Shaker is external.

The new Randomatic system, the Ling Model CP-5/6R, provides a peak random force of 2500 pounds and sine wave vector force of 1500 pounds when used with a Ling Model A-174 shaker.



BLUE M "Budget" GRAVITY CONVECTION DRY TYPE Bacteriological Incubators. Incubation at 37½°C. Inactivation at 57°C. Paraffin Embedding 47°C. to 60°C. A welcome achievement in the production of inexpensive, accurate incubators is represented by introduction of Blue M "Budget" Bacteriological Incubators at this time.

Double-wall heavy gauge steel housing and door. Sturdy; welded and reinforced for maximum endurance. Aluminum interior finish, grey baked enamel exterior. Insulation 2" thick FIBREGLASS, all sides. U.L. approved hydraulic thermostat; response sensitivity ±½°C. 2 expanded steel shelves.



Additional information sent upon request, at no charge.

BLUE M ELECTRIC COMPANY
138th & Chatham Street
Blue Island, Illinois
Phone: FUlton 5-9000

PORTABLE TEMPERATURE CHAMBER

An extremely accurate portable temperature chamber has just been announced by Delta Design, Inc., San Diego, California. Temperatures can be maintained within ±0.2°F. over a range of -100°F to +500°F. This close control is accomplished by a meter-relay in conjunction with a copper-constantin thermocouple.

The new 1060 Series includes a rack mounted model with test volume of 10"x7"x7", two bench models with the same test volume, and a wide drawer model with test volume of 16"x7"x7". Liquid CO_2 automatically cools three of the new chambers, while dry ice (solid CO_2) is used in the fourth chamber.

The liquid CO_2 cooled chambers, in addition to providing extremely fast temperature pull-down, can be programmed with a simple auxiliary timer to alternate between a high and low temperature.

For further information, write:

DELTA DESIGN, INC. Sales Office
7460 Girard Avenue
La Jolla, California

ACCELEROMETER CALIBRATOR

The Model 4290 Calibration Exciter is designed to vibrate Accelerometers or other small vibration pick-ups at a constant test level over the frequency range from 50 to 30,000 c/s. The Exciter, manufactured by Bruel & Kjaer, features a very small accelerometer built into the table as a monitor for servo regulations of the driving

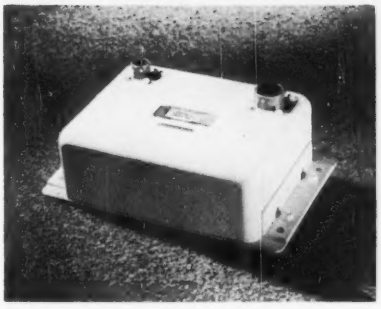
Signal Generator to obtain the constant vibration level. According to B & K Instruments, Inc., 3044 West 106th Street, Cleveland, Ohio, the Model 4290, in combination with the Bruel & Kjaer Model 3301 Response Recorder, will automatically measure and plot an accelerometer frequency response calibration from 200 to 20,000 c/s and indicate its mounted resonance up to 50,000 c/s.

AIRESEARCH DEVELOPS NEW POSITIONING TEMPERATURE CONTROLLER

A radically new positioning and temperature controller offering weight and size advantages not possible in previous control concepts is in production in The Garrett Corporation's AiResearch Manufacturing Division of Los Angeles.

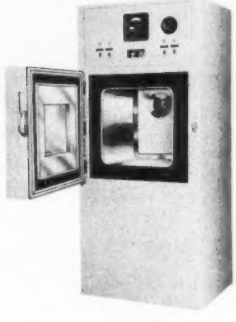
The new control, designed to operate standard D.C. electric valves or positioning actuators, is a proportional pulse, modulating control, using silicon controlled rectifiers (SCR) as the output device.

The basic control utilizes a simple miniaturized magnetic amplifier for the input stage. The output of this amplifier is applied through appropriate pulse forming circuitry to the gating electrodes of a pair of silicon controlled rectifiers.



The silicon controlled rectifiers act as switches which gate rectified A.C. to the appropriate field winding of the actuator or valve motor in response to a given signal applied to the input of the control.

Present production controls have been designed to operate over an ambient temperature of minus 65 to plus 250 degrees F. Price of the new AiResearch positioning and temperature controller is competitive and furnished on request.



A new environmental test cabinet with special "add-on" facilities for altitude, vacuum, humidity and temperature testing has been developed by Hudson Bay Co., a division of Labline, Inc.

The Com-pac Cab, as it is called, was designed specifically for effective low temperature operation with an adjustable temperature range from 300°F to −120°F. It functions with complete dependability for varied testing by merely adding optional equipment. The working chamber is 19" x 19" x 19". It is electrically welded and resistant to high pressures.

The unit has a sealed-in oil supply and a built-in thermal overload protector. Over-all dimensions are 74" x 32" x 32", which allows easy, compact installation. It is electrically powered by a 230 volt, 60 cycle, single phase motor. It may be ordered as a horizontal or vertical free-standing floor unit or for bench use.

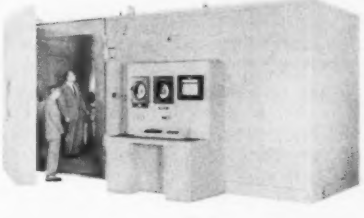
For further information, write or wire:

Hudson Bay Co., Division of Labline, Inc.
3070–82 W. Grand Ave.
Chicago 22, Illinois

FLIGHT TEST SIMULATOR

Dr. Carl T. Ashby, Conrad, Inc., President and Director of Engineering, and *Charles F. Conrad*, Application Engineering Manager, are shown inspecting a Conrad, Inc. flight test simulator. The flight test simulator is one of only a few in existance capable of combining altitude and temperature conditions with a full range of vibration tests.

An electronic vibration exciter can be installed within the walk-in size test chamber. It permits true reproduction of vibration conditions from a missile in flight to be "played back" through the electronic equipment within the Conrad chamber. Environmental temperature and pressure conditions of space flight can also be exactly controlled and reproduced.



GENERAL ACOUSTICS ANNOUNCES NEW PREFABRICATED TEST ROOMS

General Acoustics Corporation, West Los Angeles designers and manufacturers of noise control equipment for the aircraft and missile industry, announced this week the production of a new line of prefabricated modular insulated panel structures.

The prefabricated chamber is constructed of modular sound panels that incorporate highly absorbent inside faces and special laminar core materials that prevent noise from transmitting through the walls. The modular design of the

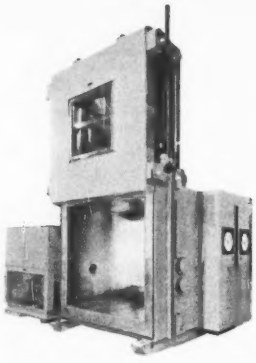
panels permit easy assembly and disassembly of the test chambers as well as future expansion, or modification. The basic standard panels that are 28" wide by 8' or 10' long are supplemented by an observation window panel, and special single or double insulated door sections. By using these modular sections an infinite variety of test chambers can be provided.

Further information may be obtained by writing:

General Acoustics Corporation
12248 Santa Monica Boulevard
Los Angeles 25, California

TEMPERATURE ALTITUDE HUMIDITY CHAMBER

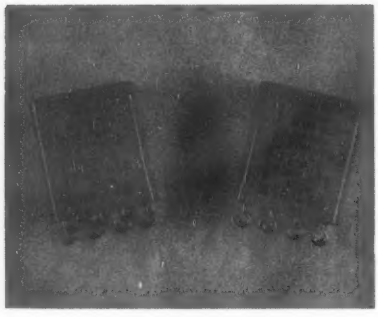
The following is information of a newly designed altitude-temperature-humidity simulation chamber. It has a temperature operating range of –120° F to +300° F. The humidity cycle is designed for 20% to 95% over a temperature range of +35° F to +185° F as limited by a +35° F dew point. The altitude range is ambient barometric to 100,000 feet. This chamber is actually designed to withstand the pressures of perfect vacuum, if a higher altitude range is required, only the vacuum pump capacity has to be increased.



The stainless steel dimensions are 6' x 6' x 6' or a total of 216 cu. ft. The F13/F22/ Cascade refrigeration system is designed so that it can be mounted on either side or rear of the test chamber.

For further information you may contact:

Murphy & Miller, Inc.
600 West Taylor Street
Chicago 7, Illinois



RELAY ENVIRONMENTAL BREAK–THROUGH

A series of recent tests indicate 60g, vibration resistance in the new Control Dynamics Micro Miniature Relay.

Evaluation testing by Litton Industries showed *"No Discernible Contact Chatter"* at 45g. One relay of the test group was tested to 97g *"With No Apparent Contact Chatter"*.

Manufactured in the .200 grid "printed circuit" terminal header pattern, and in resistances from 0.1 to 10,000 ohms.

Available for dry circuit, 2 amp (at millions of cycles), and 10 amp models.

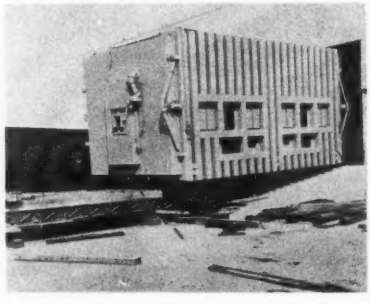
One of the largest environmental test chambers ever shipped overland in one piece was recently delivered by the American Research Corporation to a leading research and development firm in the space missile field.

This temperature-humidity-altitude chamber has a free test area of 10' high x 10' wide x 24' long, and was completely pre-tested and shipped as one package, so that a minimum of installation was required.

The chamber has a temperature range of from –100° F to +350° F and will simulate altitudes up to 150,000 feet. It is completely automatic in operation, including push button control of the large doors which provide access for the test items.

Please write to:

The American Research Corp.
Farmington, Connecticut



ENDEVCO ANNOUNCES UNIQUE RING–SHAPE ACCELEROMETER

Endevco Corporation announces the Model 2221 ring-shape accelerometer – 0.60 inch dia. by 0.43 inch high, weighing 11 grams (0.3880 oz.) – with central mounting hole, 6-32 x 5/8, allowing connector alignment and standard mounting hardware for ground isolation. The Model 2221 has a high first resonant frequency of 25 KC, sensitivity of 5pk-mv/pk-g (charge sensitivity: 1.4 micromicrocoulombs plus dynamic range of 2000 g's. This new accelerometer provides frequency response from 2 cps to 4,000 cps ± 5% cross-axis sensitivity and operates over temperature range of –40° F to +230° F with a maximum sensitivity change ± 10%. The unit is electrically isolated from ground with Endevco insulated mounting screw.

For additional technical information, write:

Endevco Corporation
161 East California Blvd.
Pasadena, California
Phone: SYcamore 5-0271

NEW FACILITIES

AMERICAN ELECTRONICS, INC., INSTALLS LARGE LIQUID CO_2 SYSTEM

American Electronics, Inc., American Laboratories Division, has installed one of the largest and most complete liquid carbon dioxide distribution systems presently in operation on the West Coast, according to *W. H. Grumet*, Division General Manager.

The system was designed, installed and is serviced by Cardox, Division of Chemetron Corporation, Los Angeles, and is particularly suited to the special requirements of American Laboratories, a prominent independent commercial environmental test laboratory, since carbon dioxide may be stored indefinitely under refrigeration and pressurized conditions.

Now in operation, the system comprises a 22-ton mechanically refrigerated and pressurized storage area, and 28 individual outlets located throughout the laboratory, as well as a completely insulated distribution system to these outlets.

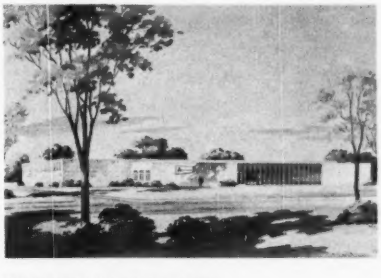
American Laboratories specializes in environmental testing for military, commercial and industrial uses, particularly for electronic, missile and space applications.

GARRETT FORMS NEW SUBSIDIARY

The formation of a subsidiary company, Garrett (Japan) Limited in Tokyo, has been announced by *E. A. Bellande*, Vice President of foreign operations for The Garrett Corporation, Los Angeles.

At the same time the appointment of *Seichi Akabane* as resident representative managing director of Garrett (Japan) Limited has been announced. Offices have been established in the Daini Goto Building, 9 Roppongi, Minatoku in Tokyo.

The Garrett Corporation manufactures component parts and systems for aircraft and missiles, and now operates through four subsidiaries and seven divisions including AiResearch Manufacturing Divisions in Los Angeles and Phoenix.



BIGGER HOME FOR GROWING YOUNG CORPORATION

Associated Testing Laboratories, Inc. -- environmental testing laboratory and manufacturer of environmental test equipment -- will move into a new plant in Wayne, New Jersey, early this year, it was simultaneously announced today by *William Tonkowich*, President, and Mayor *Robert A. Roe.*

Mayor Roe stated that this is the second major laboratory to locate their facilities in Wayne in the last year, indicating the many desirable advantages of the community.

The new 30,000 square foot building, estimated to cost approximately $500,000, will be twice the size of the company's present facilities in Caldwell.

LING–ALTEC RESEARCH DIVISION ANNOUNCED

Announcement of the formation of Ling–Altec Research Division has just been made by *Cameron G. Pierce*, President of Ling–Altec Electronics, Inc. The New division will be headed by *John K. Hilliard* as Vice President and Director. *Dr. Walter T. Fiala* will serve as Chief Physicist.

Creation of this new research and development division provides the Corporation with a facility that will plan future products for the various divisions and subsidiary companies of the Corporation.

The facilities of Ling–Altec Research Division will be available on a contract basis to the military and industry requiring development of new products in the high powered electronics covering sonar, radar, environmental testing, and acoustics.

Continued on page 29

Names and Faces

The addition of *Glen R. Larson* to the Sales Engineering staff of the Oakland, California headquarters office of The Rucker Company, has been announced by *Clark E. Rucker*, President.

Larson, who has a broad background of experience in industrial research and design, received his formal education at Illinois Institute of Technology, where he received his M.E. degree.

Prior to his appointment with The Rucker Company, *Mr. Larson* held positions as Field Engineer and Branch Manager with Hydraquip Corporation, Dallas, Texas; Chief Engineer, United Machine Company, Fort Worth; and Design Engineer, Commercial Castings Co. Engineering Division, Los Angeles. He is a member of American Society of Tool Engineers and American Society of Mechanical Engineers.

Edward F. Talbot of Beverly, Massachusetts has joined Equipment Sales Company, Incorporated, of New Haven, Connecticut, as a Field Sales Engineer. *Talbot* will work with *Bob Graeff* and *Jim Barry* out of the Boston area branch office at Danvers.

Equipment Sales Company, Incorporated has specialized for many years in environmental testing equipment and related instrumentation. *Ben Chase, Bob* and *Angus MacArthur* and *Bob Matt* provide service for Eastern New York State and Western New England from the New Haven office.

ERNEST CUMMINGS NAMED FIELD ENGINEER

Ernest W. Cummings has been named Field Engineer for Denison Engineering Division, American Brake Shoe Company, Columbus, Ohio, *Denison Neale*, Director of Sales announced today.

Mr. Cummings will be located in Pittsburgh, Pennsylvania for the sale of hydraulic pumps, motors and controls in the Western Pennsylvania and West Virginia area.

A 1951 graduate of the University of Washington with a degree in business administration, he was previously associated with the Trane Company of LaCrosse, Wisconsin, as Sales Engineer.

John M. Thompson, former Laboratory Chief of the Test Facilities Laboratory, Rome Air Development Center, at Griffiss Air Force Base, has recently resigned after 25 years of government service to accept an appointment as Vice President and General Manager of ITEMLAB, Inc., Port Washington, New York.

The Board of Directors of Associated Testing Laboratories, Inc., at a recent meeting, made the following management changes: *George E. George*, President of George, O'Neill & Co., Inc. was elected a director; *William Tonkowich*, a Director, was re-appointed President of the company; *Bernard Novack*, a Director, was re-appointed Vice President; *Albert F. Erdman*, a Director, was appointed Secretary.

The appointment of *Sidney Gerhard* as Chief Engineer, Propulsion Test Facilities, has been announced by *Norman G. Froomkin*, Vice President and General Manager. PTF is a division of MB Electronics, a Division of Textron Electronics, Inc.

Prior to his new position, *Mr. Gerhard* was Chief Engineer, Test Equipment Division, Consolidated Diesel Electric Corporation, Stamford, Conn., and Chief Project Engineer, Hydraulic Test Equipment, Greer Hydraulics, Inc., New York.

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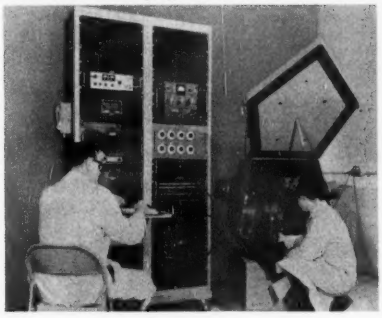

NEW ACOUSTIC–NOISE TEST SYSTEM

The development here by Associated Testing Laboratories, Inc. of a new acoustic-noise test facility to duplicate the high intensity sounds found to be present in the proximity of high-thrust jet and missile engines was announced today by *Albert F. Erdman*, company Chief Engineer.

This equipment will be used to evaluate the ability of missile and aircraft components and systems to operate and function properly under simulated flight conditions.

It will accurately and realistically produce sound pressure levels up to 150 decibels overall intensity within eight controllable octave bands. These bands cover a frequency range of 37.5 to 9,600 cycles per second.

1960 PROCEEDINGS AND REPRINTS OF PAPERS WILL BE ON SALE AT THE I.E.S. BOOTH.

ORDERS WILL BE TAKEN FOR COPIES OF THE 1959 PROCEEDINGS. PRICE $12.00. TO MEMBERS $8.00. 273 PAGES - OVER 50 PAPERS WELL ILLUSTRATED. PROCEEDINGS ARE A GOOD SUMMARY OF STATE OF THE ART IN THE ENVIRONMENTAL FIELD.

Membership in IES

Several classes of membership are provided in the Institute of Environmental Sciences which parallel those of other societies, namely: Fellow, Honorary Fellow, Member, Associate Member, Student, Government Member, and Company Member. Requirements for the individual classes of membership have been established and will be available upon application for membership. All past members of SEE and IEE have automatically been assigned the member classification without further qualification. Fellows and Members are eligible to vote and hold office. Associate Members may vote but cannot hold office. Student, Government and Honorary Members do not vote or hold office.

APPLICATIONS

For further information regarding membership write to The Institute of Environmental Sciences, Box 191, Mt. Prospect, Illinois. Attention: Russell Lowe, Vice President, Membership.

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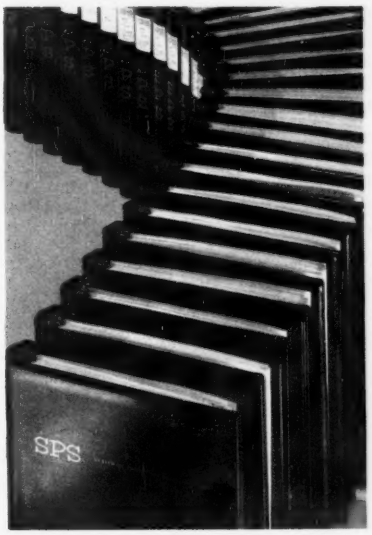
S - The DICTIONARY of test interpretation
For Engineers, Technicians, Management



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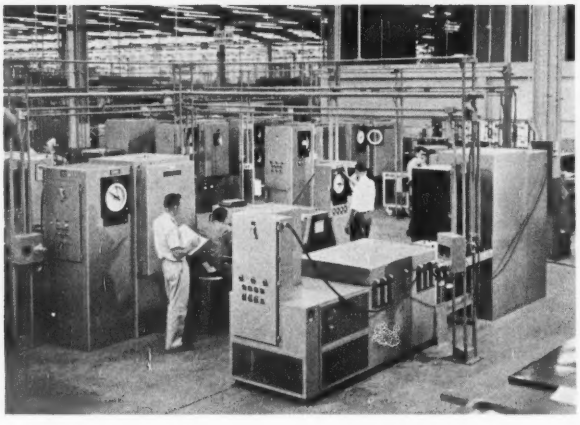

Twelve Missimers Chambers in Convair's huge laboratory include thermal shock, high and low temperature testing and humidity cycling.

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Reliability specifications of purchased electronic parts are determined through an unusually comprehensive program at Convair/Pomona, Convair Division of General Dynamics Corporation.

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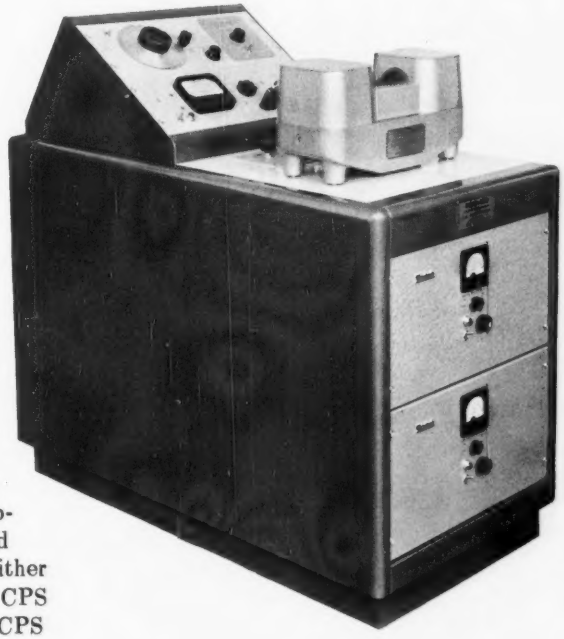

The LCM 1200 series Vibration Systems are completely self-contained within small portable consoles. Designed primarily for production testing of small components they are semi-automatic and simple to operate. Available in either of two sweep frequency ranges 5 CPS to 5000 CPS or 20 CPS to 20000 CPS with 50 force-pounds rated output.

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The Vibration Exciter is the LCM 100 which features a horizontally moving push pull driven table. The shaker table is supported by air bearings which stiffly confine movement of the table in all directions but the axis of excitation. This new air suspension system eliminates troublesome springs and flexures; and reduces crosstalk, a major problem with many shaker systems, to an exceptionally low value.

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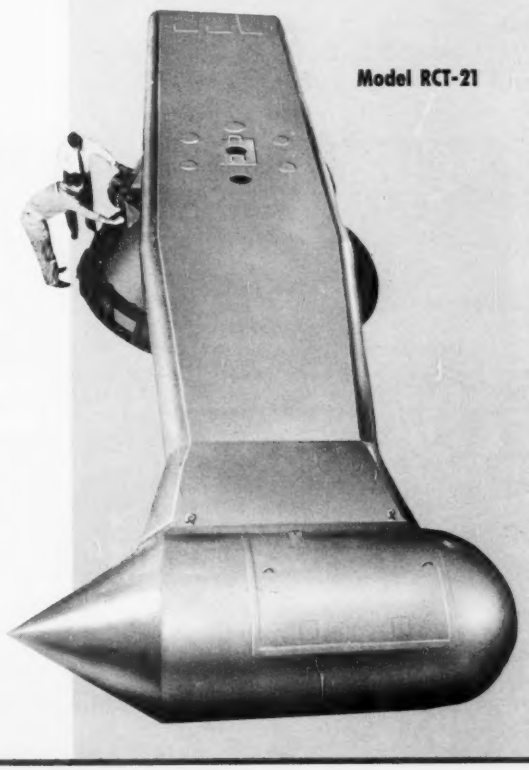
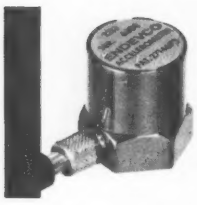


Model RCT-21



FORD VIBRATION INSTRUMENTATION: The Ford Motor Company entered the experimental gas turbine engine field in 1952. The Ford Turbo Machines Department is now engaged in research and development of a turbine engine and a working model has been tested in a tilt-cab truck. An obsolete engine, the Ford 702, has developed 160 horsepower at shaft speeds up to 36,000 rpm. ■ A new supercharged 300 horsepower turbine engine was recently announced by Ford Engineers. Known as the "704," the engine weighs 650 pounds installed, compared to 2,700 pounds for a truck diesel engine of comparable horse-

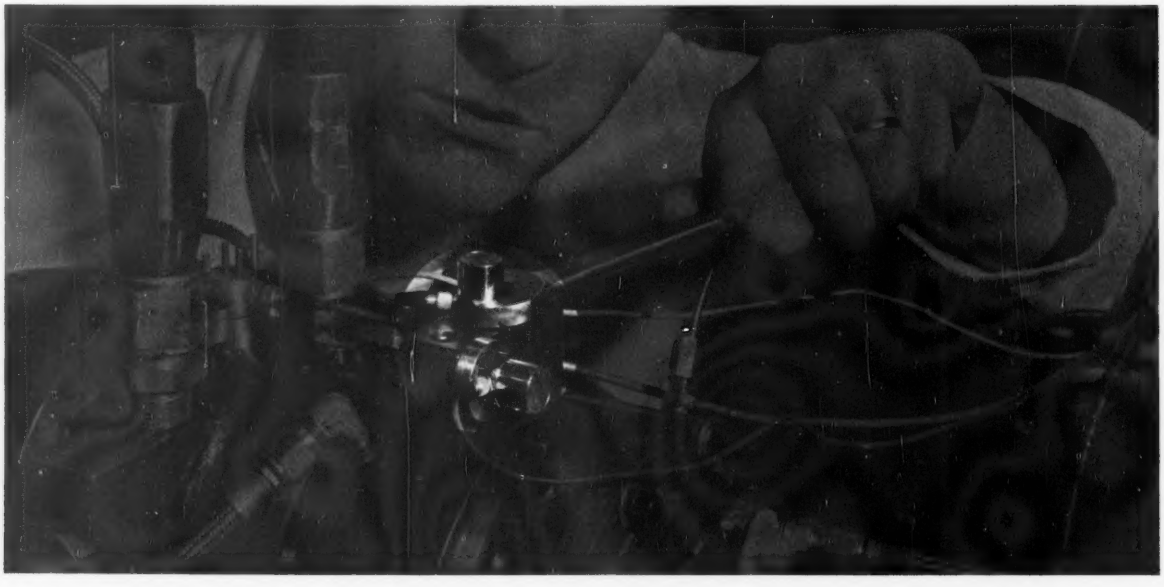
ENDEVCO TRANSDUCERS SOLVE VIBRATION ANALYSIS PROBLEM

power. The engine has two stages of compression, each operating at a 4:1 pressure ratio. Two burners are used for driving the dual compressors, the low speed wheel turning at 46,500 rpm and the high speed wheel at 91,500 rpm.

THE PROBLEM: The Ford Test program requires a wide variety of instruments to measure, control and record performance data of component parts. Measurement of vibration, for example, is a critical factor in this program. Vibrations that may cause metal fatigue, oil film breakdown, overheating, etc., are discovered during tests on individual engine "stands."

THE SOLUTION: Ford engineers use a total of six Endevco Series 2200 Accelerometers providing frequency responses up to 6,500 cycles per second. The accelerometers are connected to bearing test rigs, for example (see photo). The accelerometers relay measurements of acceleration movements in turbine shafts from three coordinates (radial vertical, radial horizontal and axial). Temperatures of the metal housings to which the standard Endevco transducers are attached average up to +150°F. Temperatures at which the water-cooled, heat-resistant models are used range up to +1000°F or more. The large self-generated output of the Endevco accelerometers eliminates the need for additional stabilization of a power supply.

THE RESULTS: The Endevco transducers are attached with a single-pole threaded bolt. The signal is fed through an Endevco amplifier to an oscilloscope or panoramic analyzer. The analyzer concentrates on a small section of the total signal and may present from 4 to 10 harmonic vibrations of different frequencies being fed from the unit at one time. This analyzer separates the frequency bands into individual bands, which it then sweeps from 20 to 40,000 cycles every second, measuring the frequency and amplitude in millivolts. ■ Ford Technicians convert these vibration records by mathematically integrating acceleration with respect to time to obtain the displacement or housing vibration. Thus, they locate the sources of objectionable resonance and take steps to eliminate or reduce vibration in the overall design. ■ Endevco accelerometers have also served as pickups for determining spring rate and damping characteristics of rubber bonded bearings. • **ENDEVCO CORPORATION** • 161 EAST CALIFORNIA BOULEVARD PASADENA, CALIFORNIA • PHONE SYCAMORE 5-0271



Close-up shows two Endevco Accelerometers on bearing test rig in Ford Instrumentation Section, Dearborn, Michigan. Cable passes to Endevco Amplifier (not shown on right).

You're looking at a dramatic advance in transmission design. This integral, variable speed drive system, based on the new Rouverol® ball-galaxy principle, achieves high torque characteristics while maintaining the inherent accuracies of a hardened steel-to-steel ball-disc integrator. This accuracy gives the new Genisco A-Series Centrifuges a constancy of boom rotation, including wow and drift, of better than 0.05% at any speed setting above 0.1 g—*approximately 10 times more accurate than similar competitive machines!*

But accuracy is only one advantage of the new Genisco A-Series Centrifuges. Simple, rugged, building-block construction results in exceptionally trouble-free operation. Basket-type mounting platforms may be oriented from the horizontal to the vertical, or to the inverted attitude, for multiple-axis testing without demounting the test object. Available accessories include additional slip rings, microwave joints, high pressure air and hydraulic systems, TV viewing systems, built-in electronic counters for simplifying precise rate monitoring, and servo control for programming purposes.

If you are testing to MIL-E5272C get complete information on these three great new centrifuges.

BRIEF PERFORMANCE SPECIFICATIONS

Model No.	Diameter	Test Object Weight	Capacity G-Pounds	RPM Max.	G-Range Max.	Test Object Dimensions
A-1010	30" table	50 lbs. dead weight	2,500	800	.1 to 200 g's	
A-1020	60" arm	100 lbs. dead weight	10,000	600	.1 to 250 g's	12" cube
A-1030	96" arm	100 lbs. dead weight	10,000	355	.1 to 150 g's	18" cube

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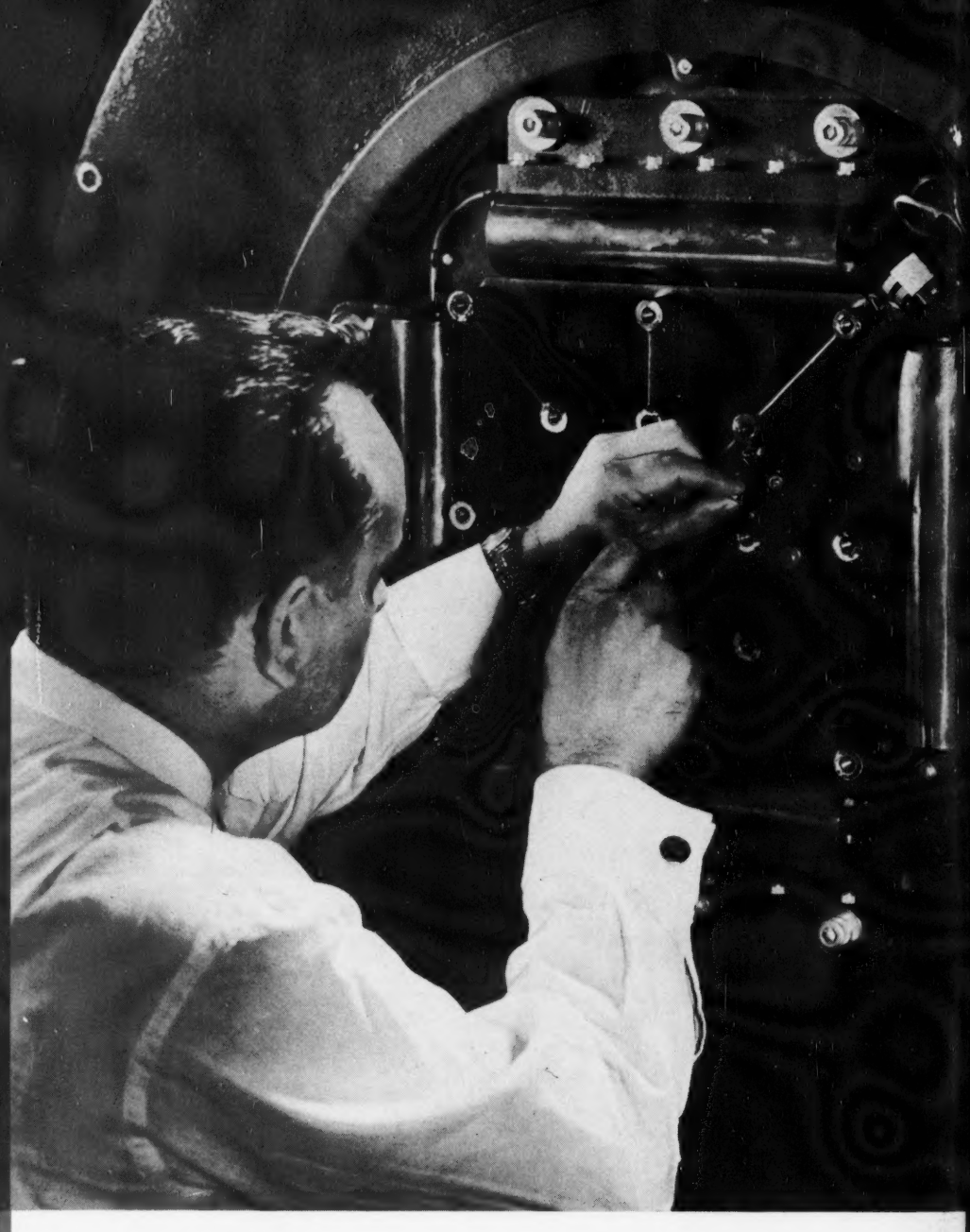

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